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(54) Method and apparatus for performing procedures

(57) An apparatus and method for guiding human operators through a sequence of maintenance and repair tasks such as the removal of paper jams in complex reprographic equipment. The invention comprises the placement of human interpretable indicators (15,16) in locations corresponding to various operations to be performed by an operator and then activating such indicators in sequence when sensors and a control algorithm confirm that operations preceding the operation in the sequence are completed.

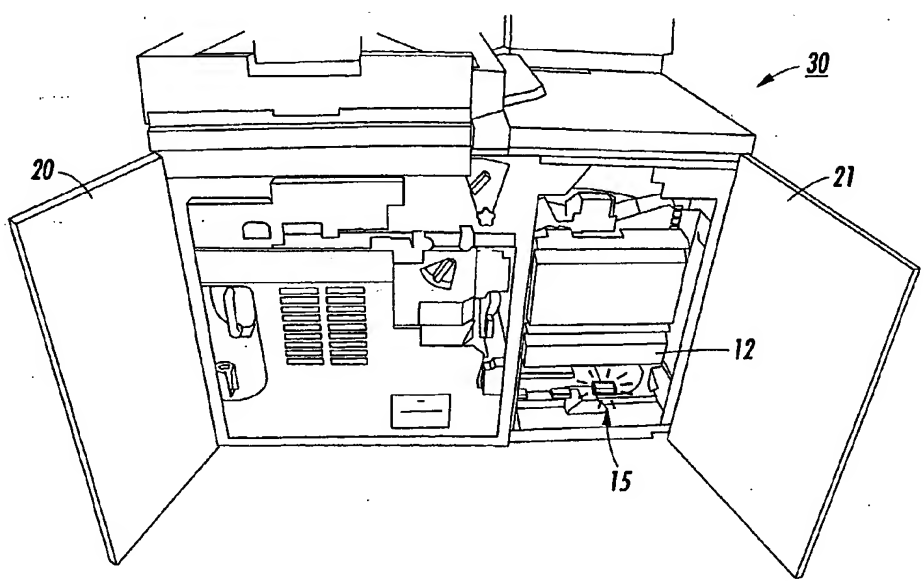

FIG. 1

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Description

[0001] The present invention relates to the field of maintenance and repair sequences for complicated equipment. More particularly, the present invention relates to apparatus and method for guiding human operators through a sequence of tasks such as removing of paper jams in complex production reprographic equipment. While this invention will be illustrated in relation to the task of removing such paper jams, it is believed that the apparatus and methods of the present invention have wide applicability, particularly to routine maintenance or repair operations to be performed by human operators that have not been specially trained and for such operations when many variables combine to vary the sequence from one operation to the next.

[0002] It has become common for printing systems to include a series of sensors designed to detect the location where a paper jam occurs.

[0003] In many printing machines, the UI instructs (user interface) the operator in the case of a jam which cabinet doors must be opened and/or components like finishers must be separated.

[0004] It has become routine for operators to rely upon information displayed in the UI or other human interface to determine whether assembly or disassembly operations have been properly completed and, if so, which operations are to be performed next in the sequence. This often requires that an operator move back and forth between the UI and the cabinet or work space where the operations must be performed. The larger and more complex the equipment, the more important guidance from sensors within the system and cooperating control algorithms becomes. Also, the less trained the operators, the more reliant upon such instructions in a UI the operator becomes. For an equipment manufacturer, it is desired that machines be as easy to maintain as possible by customers in order to avoid service calls and to require as little operator time and training as possible.

[0005] In accordance with a first aspect of the present invention, an apparatus having procedures to be performed and having parameters indicating apparatus status including fault parameters and nominal parameters comprises:

a. a first human interpretable indicator located proximate to an apparatus site where a procedure is to be performed;
b. a second human interpretable indicator located proximate to an apparatus site where a procedure is to be performed;
c. a first sensor, associated with the first human interpretable indicator, for sensing an apparatus status parameter at the site proximate to the first human interpretable indicator;
d. a second sensor, associated with the second human interpretable indicator, for sensing an apparatus status parameter at the site proximate to the second human interpretable indicator; and
e. a controller for determining a sequence of procedures, said controller communicating with the first and second human interpretable indicators and the first and second sensors wherein, in response to a signal from the first sensor that a fault parameter exists, the controller directs activation of the first human interpretable indicator and, in response to a signal from the first sensor that a nominal parameter exists, inquires of the second sensor whether a fault parameter exists and, if such fault parameter exists, directs activation of the second human interpretable indicator.

[0006] In accordance with a second aspect a process for guiding human operator procedures for an apparatus having parameters indicating system status including fault parameters and nominal parameters comprises:

a. sensing a fault parameter by a first sensor;
b. activating a first human interpretable indicator proximate to the parameter site sensed by the first sensor;
c. in response to sensing a nominal parameter at the first sensor, interrogating a second sensor to determine whether a fault parameter is sensed by the second sensor; and
d. in response to sensing a fault parameter by the second sensor, activating a second human interpretable indicator proximate to the parameter site sensed by the second sensor.

[0007] It is advantageous to have an apparatus and process that automatically guides an operator through various sequences for maintenance and repair without the need to continually refer to repair manuals or to human interfaces such as a systems UI. Such an automatic guide system preferably allows an operator to remain in situ at the place of repair, maintenance or reassembly without needing to physically move or to change the focus of his/her attention. With such an automatic guide system, repair, maintenance, and assembly/reassembly processes become more efficient and more reliable with decreased risk that an improper sequence will damage components, and require less training for human operators. A further advantage is that the present invention not only may be adapted to guide the sequence of operations but may, in addition, be adapted to direct movements or other manipulation of levers, latches, pulls, knobs, drawers, etc.

[0008] An example of a method and apparatus according to the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is an elevated perspective view of an apparatus of the present invention showing illumination of one human interpretable indicator;
Figure 2 is an elevated perspective view of an ap-

paratus of the present invention showing illumination of a second human interpretable indicator;

Figure 3 is an elevated perspective view of an apparatus of the present invention showing illumination of a third human interpretable indicator;

Figure 4 is an elevated perspective view of an apparatus of the present invention showing illumination of a fourth human interpretable indicator placed on cabinet doors;

Figure 5 is an elevated perspective view of an assembly/reassembly fixture of an apparatus of the present invention showing human interpretable indicators capable of conveying greater status information and manipulation information;

Figure 6 is the first portion of a logical sequence depicting a process embodiment;

Figure 7 is a second portion of a logical sequence depicting a process embodiment; and

Figure 8 is a third portion of a logical sequence depicting a process embodiment.

[0009] Turning now to Figures 1-4, a sequence for clearing an exemplary paper jam in an electrophotographic printing machine is shown. Not all paper jams will occur in the same locations or require the same sequence even for the same machine. In the example shown, sensors within the machine have detected a misfeed from copy sheet feeder apparatus (not shown). The machine has halted operation and informed the operator that a jam has occurred. The UI (user interface), not shown, schematically has informed the operator that the two main cabinet doors need to be opened. The controller and sensors have cooperated to determine which sheets undergoing processing can be processed through to completion and which must be halted along the sheet path.

[0010] As the operator opens the two main cabinet doors, he sees the scene shown in Figure 1. He cannot see the paper itself because the sheet path is buried behind various subassemblies and baffles. He also cannot know where the paper jam occurred or at which stations and subassemblies sheets have been stopped in situ. Under the prior art, the operator would typically have looked at the schematic presented in the UI to have a sense (but not certainty) where to look for paper to be removed. He may look for green or distinctive handles and levers if these are available. He then proceeds to clear one station and then look at the UI for information regarding another station to be cleared. In other words, he continues to look between the insides of the cabinet and the UI that is placed on top of the machine. At best this requires raising and lowering his head. More probably, he must raise and lower his body to first see the UI and then return to the cabinet to perform the next operation. Worse, there may be multiple sheets to be cleared at any one station. If he clears one sheet and moves on to the next station, then he may not know that one or more sheets were left behind until he believes he has completed the job, has closed the cabinet, stood upright, and then discovers that the UI is still indicating a paper jam somewhere in the equipment. As discussed above, in even more complex equipment having positioning clamps, levers, drawers that are pulled out and then pushed back into place, the operator may not know that the reassembly was incomplete until he closes the cabinet doors and is informed of a fault by the UI. Worse, delicate calibration and alignments between subassemblies may be disturbed if parts are clamped or otherwise placed under pressure when not completely reset in the proper position.

[0011] Accordingly, Figure 1 shows an embodiment of the present invention where the operator opens the cabinet doors 20 and 21 of printer 30 and immediately sees an illuminated handle, lever, or other disassembly fixture 15. Such illumination 15 may be by a switched incandescent or fluorescent light bulb or, preferably, illumination by such means as LEDs embedded into the disassembly fixture itself. It is possible that indicators other than illumination will work, such as sound or blinking lights, but the invention will be explained using illumination as the user indicator. Such illumination immediately draws the operator's attention to disassembly fixture 15 and informs the operator which step is to be performed first. He does not need to guess which procedure to implement first nor which disassembly fixture will implement the chosen disassembly procedure.

[0012] Advantageously, when the operator has correctly completed the first step, the illumination at fixture 15 ceases and, as shown in Figure 2, an other illumination draws the operators attention to fixture 16. Importantly, illumination of fixture 15 will not cease and illumination at fixture 16 will not commence until the work at fixture 15 is correctly completed. Thus, if the operator has removed one sheet from the copy feeder assembly 12 and, in fact, two or more sheets need to be cleared, then fixture 15 remains illuminated even after the operator returns any moved parts back to their operational position. Equally important, if some component had been moved during the operation at fixture 15 but had not been returned to its proper position, then fixture 15 would remain illuminated, and the operator would know that something needed correction.

[0013] When contrasting the above to the prior art, it is clear that continual reference to the UI for instructions has been essentially eliminated, and the operator can remain focused on the equipment in front of him rather than needing to focus on multiple locations. In other words, once the UI refers the user to the cabinet doors, this transfers the user's attention from the UI itself to the illuminated handles. The handles become the user's interface with the machine until the jam is cleared, at which point, the user transitions back to the UI. Also, the operator gets immediate feedback whether the disassembly and reassembly has been performed correctly. The likelihood of damaged components due to failure to reassembly in the correct order or location has been

greatly reduced or eliminated. Lastly, an operator will not experience the situation of believing that the repair has been finished with the cabinets closed only to find that some operation or procedure has been missed.

[0014] Returning to Figure 2, the operator's attention is drawn to illuminated fixture 16. As above, the present invention provides the operator confidence that procedures at fixture 15 have been completed successfully. By illumination at fixture 16, the operator need not guess which operation to perform next or which fixture to manipulate in order to perform the procedure.

[0015] Turning to figure 3, the operator observes that fixture 16 is no longer illuminated, and his attention is immediately drawn to the newly illuminated fixture 17. As described above, this switch in illumination conveys valuable information, including that the preceding operation was completely thoroughly and correctly. Upon completing the operation at fixture 17, the operator will observe that illumination has moved to cabinet doors 20 and 21. In addition to informing the operator that the operations at fixture 17 have been completed and correctly performed, illumination at the cabinet doors informs the operator that the repair has been completed. In this case, illumination of the doors indicates that the sheets jammed in the printer have all been removed. Of course, any type of overall completion indicator could be employed, including sound emitters or lights at a different location than the cabinet doors. Whichever completion indicator is used, however, the operator knows that he does not need to continue searching for more jammed paper and need not disturb other portions of the apparatus. In the long term, such minimization of effort both increases operator efficiency and preserves wear and tear on equipment and parts. Also, minimal disturbance of components helps preserve calibration and tolerances within the machine.

[0016] It will be understood that the more complex the apparatus to be operated upon, the more valuable the present invention will generally become. Particularly with systems such as printers that often require simple maintenance and monitoring by minimally trained operators, the present invention makes such maintenance more efficient and more likely to succeed while minimizing the opportunity for damage to the components.

[0017] Turning now to Figure 5, close-up perspective view shows several additional embodiments of the present invention. Specifically, handle 40 is a grip handle to enable an operator to slide a portion of a subassembly in the direction of arrow 41 in order to obtain access to a jammed sheet. As shown, handle 40 has two sets of illuminators. LEDs 44 and 45 are colored red and green, respectively. As long as the controller senses a sheet at the location of handle 40, the red light 44 remains lit. The operator knows that all sheets accessible by handle 40 have been removed when the red LED 44 is dimmed and the green light 45 is lit. This variation on the present invention provides the operator with even more information since he does not need to return handle 40 to its operating position without knowing with certainty that all sheets have been removed that should be removed. Without this feature, the operator will not progress to the next station under the present invention but he may open and close handle 40 multiple times until the LEDs on handle 40 are extinguished and the next set of illuminators light up.

[0018] A second feature revealed in Figure 5 is a directional signal 42, 43 formed by LED lights. These indicate to an operator which direction the handle is to be moved for the correct operation. For untrained operators dealing with complex machines, indicators that direct movement in one direction for opening and the opposite for closing greatly simply instructions and provide more certainty. As shown in Figure 5, direction can be indicated by a pattern of lights. Alternatively, LEDs could blink in a sequence that the human eye perceives to be leading in one direction or the other.

[0019] Turning now to Figures 6 to 8, the interplay between sensors, controllers, algorithms and illuminators of the present invention will be described. As above, an embodiment of the present invention will be described in relation to a paper jam within an electrophotographic printer. This embodiment is exemplary only and may be generalized to any number of other situations and equipment.

[0020] At step 100, a jam has occurred. At step 101 the controller enters into its fault detection subroutines, which in this case deduces that the first subassembly within the system to seize or otherwise indicate a jam must be the location where the first jam occurs. At 102, the controller signals a halt to operations that involve sheets preceding the jammed subassembly in the sheet path. Operations involving sheets in front of the jam are allowed to proceed. This feature is taught and more fully set forth in US-A-4627711 and US-A-4497569. At 103, the controller interrogates sensors determine the locations of sheets remaining after the unjammed sheet processing has continued. At 104, using algorithms or look-up tables corresponding to the locations where sheets remain stuck in the system, the controller determines which location is to be cleared next. This sheet location is selected for clearance first. At 105, the controller determines which disassembly fixtures are associated with the selected Sheet location. At 106, the controller typically refers to a look-up table to determine whether the selected sheet location requires one or a plurality of disassembly operations to obtain access to the selected sheet. If yes, then at 107 the controller again refers to a look-up table or algorithm to determine which of the several disassembly fixtures should be selected for the initial disassembly operation for that sheet location. This type of selection is frequently required when multiple baffles or tension-inducing members must be loosened in order to obtain access. For repairs in an electrophotographic engine such as changing a photoreceptor belt, many separate disassembly operations may be necessary such as above, and each oper-

ation may preferably have its own disassembly fixture.

[0021] Returning to step 107, once the controller has selected the appropriate disassembly fixture, then, at 108, a signal is sent to activate the LEDs associated with such fixture. Since there are multiple fixtures associated with this sheet location, the algorithm returns to step 106 where the loop 106-108 is repeated until all disassembly operations at the selected sheet location are completed. When all but the last such disassembly operation at that sheet location is completed, then the controller algorithm proceeds to step 109 where a signal is sent to the last fixture at that location for the LEDs to light.

[0022] It should be noted that signals for steps 108, 109, or other steps can be sent in any number of ways. Sensors and LEDs can obviously be wired for conventional electrical signals. Another embodiment is to minimize wiring within the system by sending such signals through Radio Frequency (RF) transmitters and receivers. Such RF technology is now relatively inexpensive and readily available on EEPROMs and similar semiconductor chips. One additional advantage of using RF signals is that machines produced or initially designed without the present invention can be retrofitted without introducing a major new set of wires. All that is required is a means for supplying power to LEDs, and such power can be tapped from wires carrying power near the LED sites or may even be supplied by batteries that would need to be replaced periodically.

[0023] Returning to step 110, the controller interrogates the sheet sensors whether all sheets at this location have been removed. As described above, this step is a major advantage of the present invention since under the prior art, the operator may not realize that multiple sheets at this location are to be removed. The operator may thus remove one sheet and proceed to reassemble the entire machine only to find later that additional sheets are still buried somewhere in the apparatus. The inquiry of step 110 may be sequenced on a timed manner, e.g., every 2 seconds, or may be triggered by some other event such as a change in signals sent from the sheet sensors. If the answer to the inquiry in 110 is negative, then the controller returns to step 109, and the iteration between 110 and 109 continues until all sheet sensors at this location indicate sheet clearance. As noted in relation to Figure 5, an additional embodiment of the present invention is to have two separate LED indicators at each disassembly fixture. When all sheet sensors indicate clearance, then the LEDs switch from red to green, for example, so that the operator knows that all sheets are cleared and he may proceed to the next step.

[0024] With or without such sheet clearance embodiment, completion of step 110 enables the controller to proceed to step 111. In the embodiment shown in this example, reassembly at the sheet location occurs as soon as sheets at that location have been cleared. It is also possible for some maintenance and repair operations that reassembly would not occur until later in the process, and step 111 may be moved to a later stage of the process. Regardless where placed, at step 111, the controller interrogates sensors, that may be electrical contacts in latches, pressure sensors, etc, whether the reassembly at the selected sheet location has been completed. If not, then the operator continues to see that he has work to perform at that location since the controller returns to step 109 until it receives confirmation of successful reassembly. If the sheet clearance indicators of Figure 5 have been installed, then the operator knows that the reassembly is faulty since he has received a sheet clearance confirmation. Even without this embodiment, the operator knows that something is still faulty at this location, and he again reopens the assembly, looks for additional sheets, and attempts the reassembly. As noted above, this step saves a great amount of time because the operator knows not to proceed until the LEDs at this location have dimmed.

[0025] Once the controller senses that step 111 is complete, then the applicable LEDs that location dim and the controller proceeds to step 112. At 112, the controller again interrogates the various sheet sensors to determine if additional sheets must be removed. If sensors in other locations indicate such a presence of additional sheets (which is the normal occurrence for most sheet jams), then the controller returns to step 103 and the process will be repeated.

[0026] For the operator, the great advantage is that a new set of LEDs light up another disassembly fixture, and the operator need not stand up to look at the UI nor wonder which step he should perform next. The controller, in effect, has removed doubt and made informed decisions for the operator. Also, as noted above, the operator need not perform unnecessary relating to sheets that were not jammed and were, instead, processed to completion. This ability to save operator disassembly steps saves time, effort, and minimized the wear and tear on machine components since fewer will be jostled, moved, etc.

[0027] Once the controller completes step 112 and confirms that all sheets have been removed, it proceeds to step 113 where it seeks to reconfirm that all reassembly operations have been performed correctly. If a reassembly sensor indicates that a subassembly needs readjustment, etc, then the controller returns to step 111. If all reassembly sensors check out correctly, then the controller proceeds to step 114. At 114, the LEDs associated with the cabinet doors light. This is the signal to the operator that the sheet jam process has essentially been completed. Again, the operator is saved from needing to change posture to look at the UI and is also saved from believing that he has completed the process only to find when he again stands to operate the machine that the doors must be opened again and some operation must be repeated.

[0028] At step 115, the controller inquiries whether the doors have been properly closed. This is similar to other reassembly steps in 111 and 113 and may rely upon

electrical connections in latches, pressure sensors, etc. Once an affirmative signal has been sent, then the paper jam subroutine software in the controller is exited by the controller. The software controlling performance eof the print job is resumed, and the UI once again presents to the operator information relating to job processing rather than maintenance or repair.

[0029] In sum, a process using the present invention has been presented where an exemplary routine maintenance procedure such as a paper jam has been used to illustrate the advantages and efficiencies of the apparatus of the present invention. Although the applicability of the present invention to paper jam removal has been shown, similar processes may be advantageously used for any number of repair and maintenance functions on complex hardware. It should also be noted that the same LED lights and fixtures may be used for multiple types of operations. For instance, if a photoreceptor belt required replacement in an electrophotographic printer, then a different software program than shown above would be accessed by the control mechanisms for the printer. This photoreceptor replacement software may have many of the same steps as shown above but may utilize different disassembly fixtures and a different chronological order of operations. Thus, the present invention and the processes associated therewith offer great flexibility even within the same hardware system. For each different type of procedure, different software can be accessed and different procedures can be directed by the indicators of the present invention. As shown above, another advantage is that even the same type of operation, such as a paper jam, may favorably be directed differently depending upon the specific circumstances of each occurrence. The processes and apparatus of the present invention permit a wide degree of flexibility that increase efficiency, requires less training for operators, less physical effort by operators, and less wear and tear on the apparatus itself.

Claims

1. An apparatus having procedures to be performed and having parameters indicating apparatus status including fault parameters and nominal parameters comprising:

   a. a first human interpretable indicator (15) located proximate to an apparatus site where a procedure is to be performed;
   b. a second human interpretable indicator (16) located proximate to an apparatus site where a procedure is to be performed;
   c. a first sensor, associated with the first human interpretable indicator (15), for sensing an apparatus status parameter at the site proximate to the first human interpretable indicator;
   d. a second sensor, associated with the second human interpretable indicator (16), for sensing an apparatus status parameter at the site proximate to the second human interpretable indicator; and
   e. a controller for determining a sequence of procedures, said controller communicating with the first and second human interpretable indicators (15, 16) and the first and second sensors wherein, in response to a signal from the first sensor that a fault parameter exists, the controller directs activation of the first human interpretable indicator and, in response to a signal from the first sensor that a nominal parameter exists, inquires of the second sensor whether a fault parameter exists and, if such fault parameter exists, directs activation of the second human interpretable indicator.

2. The apparatus of claim 1, wherein the second human interpretable indicator (16) is not activated until the first sensor indicates that a nominal parameter exists and, upon such signal from the first sensor, the first human interpretable indicator (15) is inactivated.

3. The apparatus of claim 1 or claim 2, wherein a transition from a fault parameter to a nominal parameter indicates that the operation at the site of the first human interpretable indicator (15) has been completed successfully.

4. The apparatus of any of claims 1 to 3, further comprising a last of a series of human interpretable indicators wherein activation of said last human interpretable indicator indicates that all sensors associated with other human interpretable indicator within the series are communicating that nominal parameters are sensed.

5. The apparatus of any of the preceding claims, wherein the apparatus comprises an electrophotographic reprographic system.

6. The apparatus of claim 5, wherein at least one sensor senses whether a sheet is jammed within the system.

7. A process for guiding human operator procedures for an apparatus having parameters indicating system status including fault parameters and nominal parameters, said process comprising:

   a. sensing a fault parameter by a first sensor;
   b. activating a first human interpretable indicator (15) proximate to the parameter site sensed by the first sensor;
   c. in response to sensing a nominal parameter at the first sensor, interrogating a second sen-

sor to determine whether a fault parameter is sensed by the second sensor; and

d. in response to sensing a fault parameter by the second sensor, activating a second human interpretable indicator (16) proximate to the parameter site sensed by the second sensor.

8. The process of claim 7, wherein the step of activating the second human interpretable indicator (16) occurs after the first sensor indicates that a nominal parameter exists.

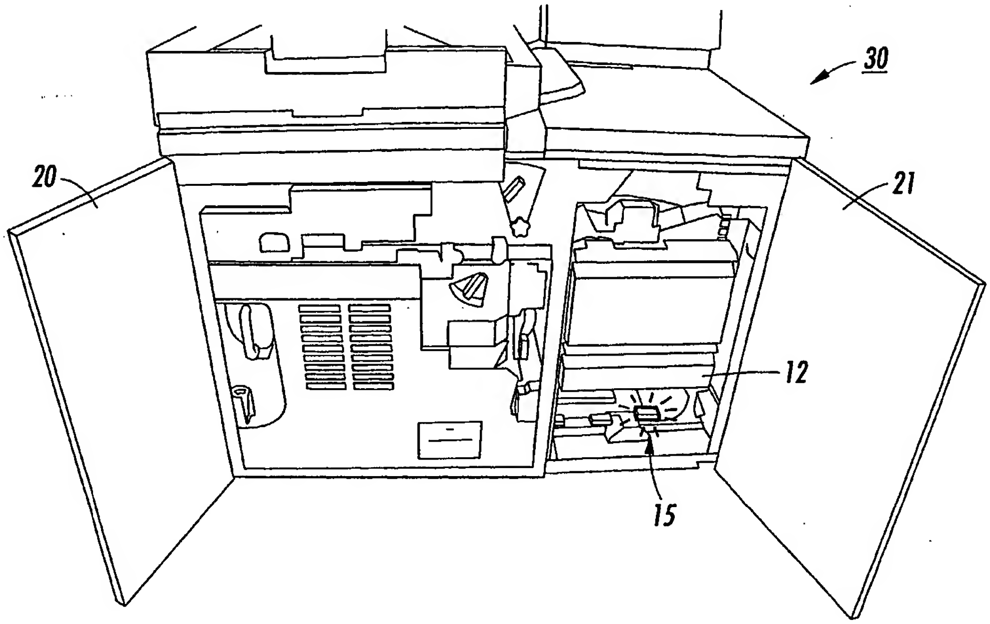

FIG. 1

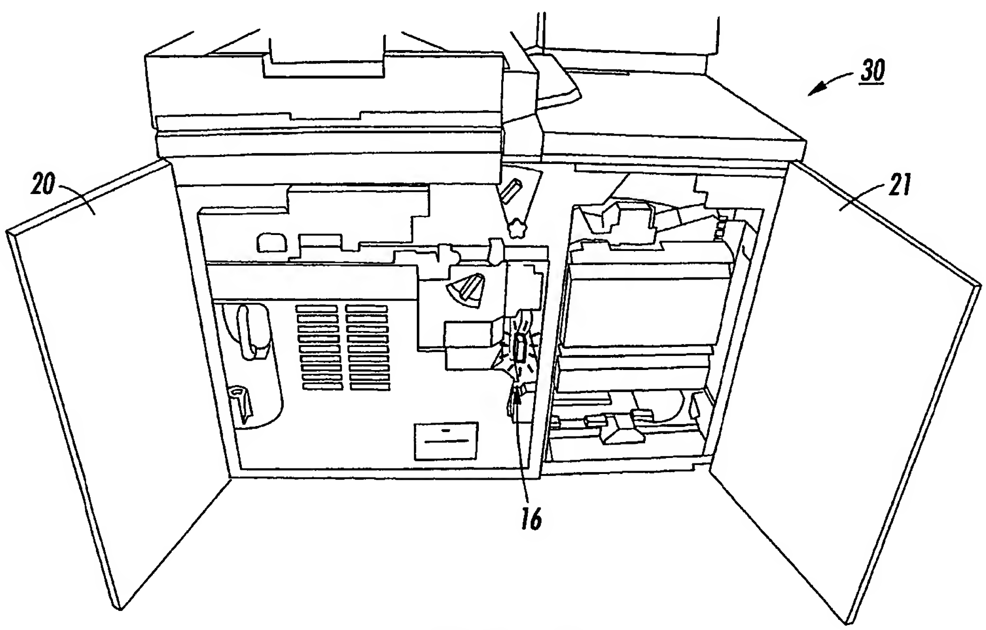

FIG. 2

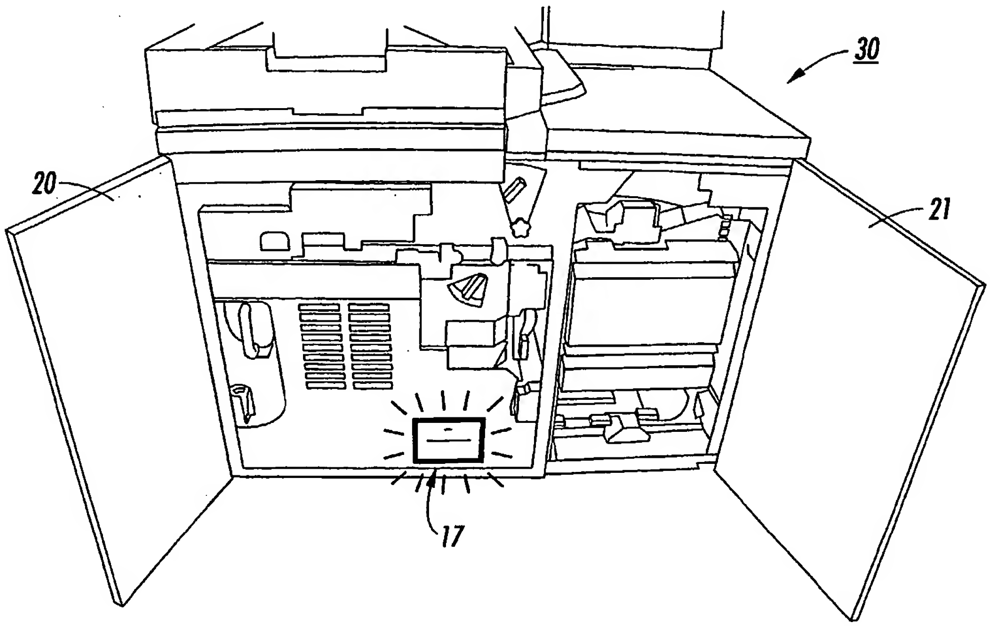

FIG. 3

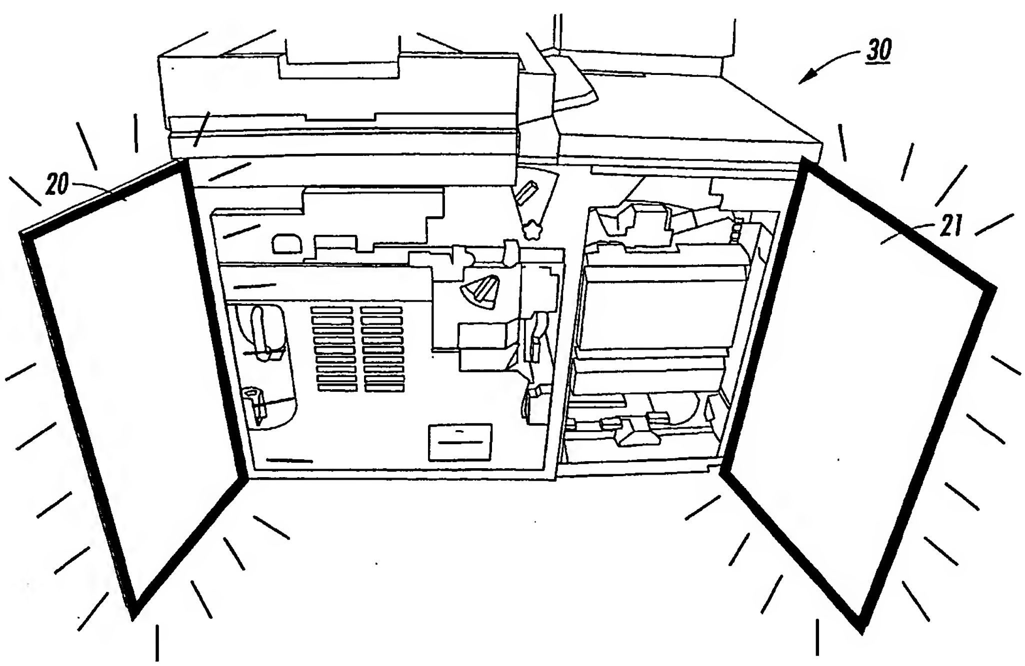

FIG. 4

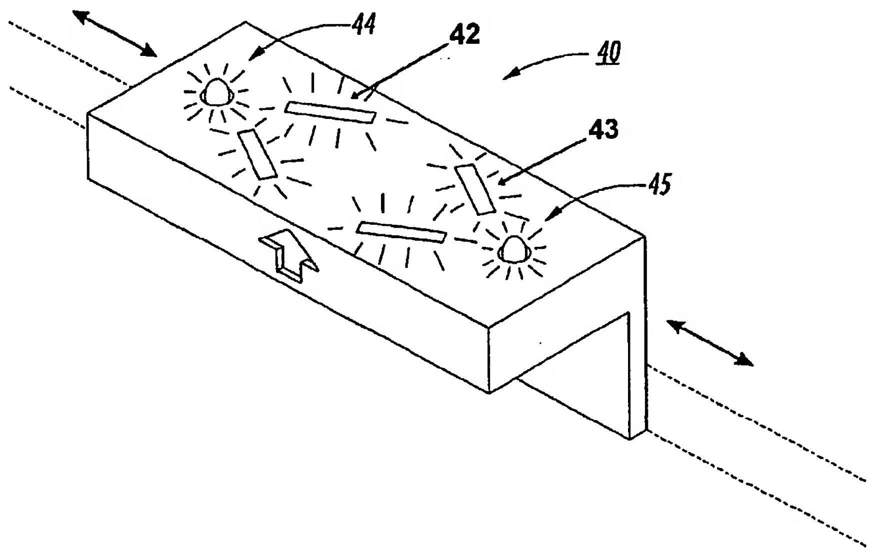

FIG. 5

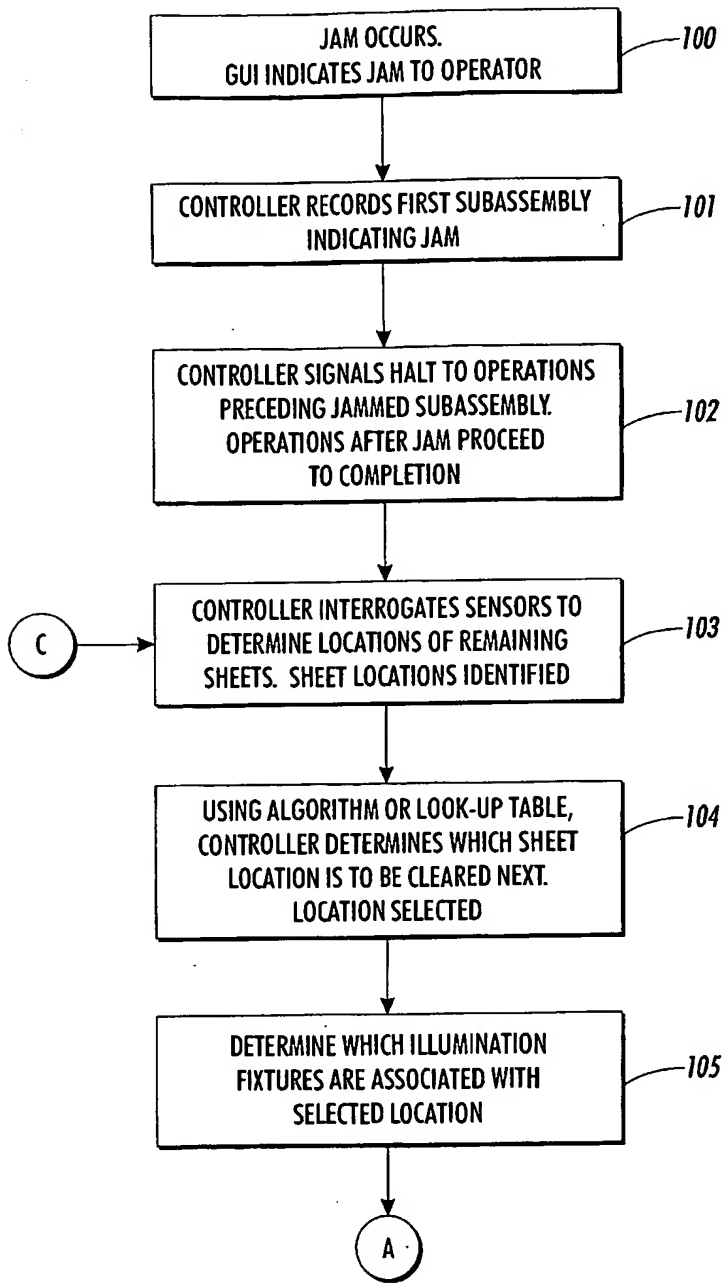
JAM OCCURS.
GUI INDICATES JAM TO OPERATOR
100
CONTROLLER RECORDS FIRST SUBASSEMBLY INDICATING JAM
101
CONTROLLER SIGNALS HALT TO OPERATIONS PRECEDING JAMMED SUBASSEMBLY. OPERATIONS AFTER JAM PROCEED TO COMPLETION
102
C
CONTROLLER INTERROGATES SENSORS TO DETERMINE LOCATIONS OF REMAINING SHEETS. SHEET LOCATIONS IDENTIFIED
103
USING ALGORITHM OR LOOK-UP TABLE, CONTROLLER DETERMINES WHICH SHEET LOCATION IS TO BE CLEARED NEXT. LOCATION SELECTED
104
DETERMINE WHICH ILLUMINATION FIXTURES ARE ASSOCIATED WITH SELECTED LOCATION
105
A

FIG. 6

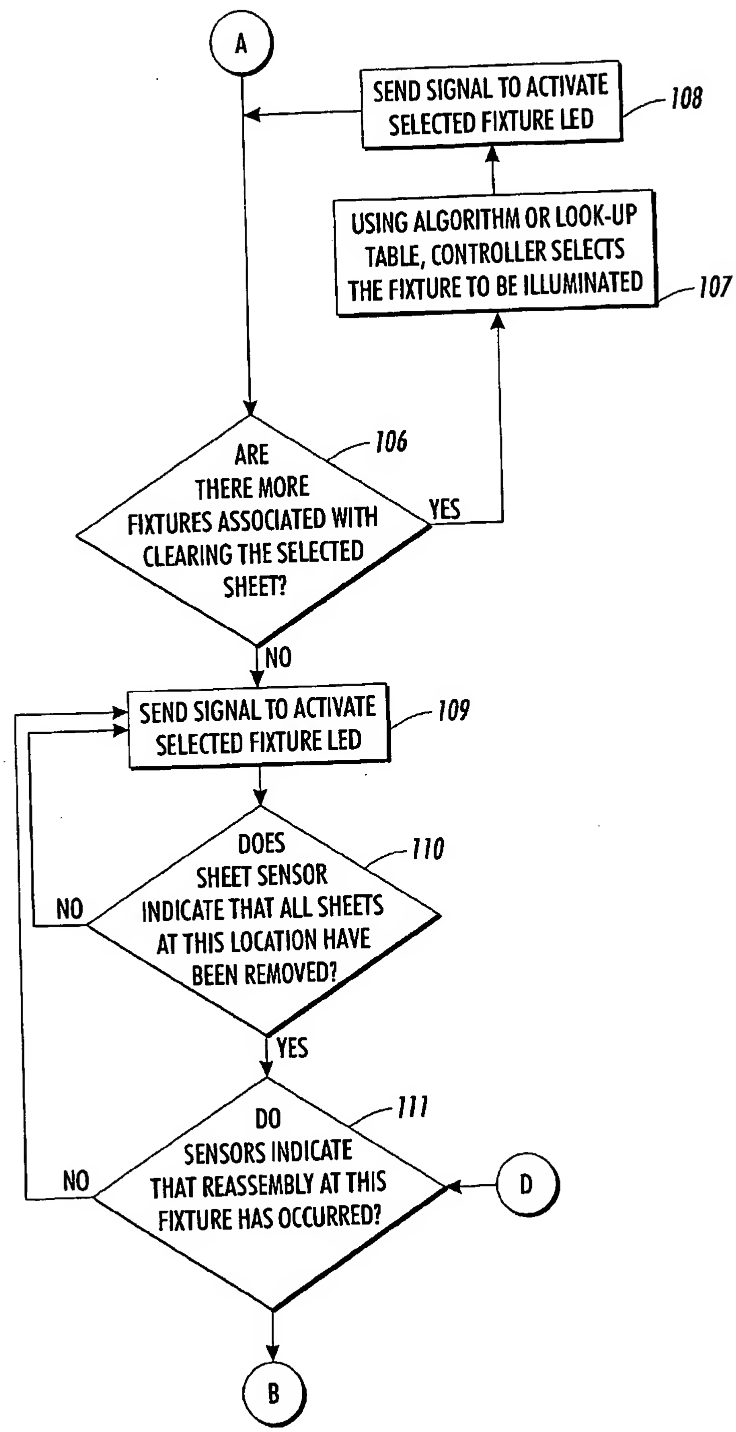
A
SEND SIGNAL TO ACTIVATE SELECTED FIXTURE LED
108
USING ALGORITHM OR LOOK-UP TABLE, CONTROLLER SELECTS THE FIXTURE TO BE ILLUMINATED
107
ARE THERE MORE FIXTURES ASSOCIATED WITH CLEARING THE SELECTED SHEET?
106
YES
NO
SEND SIGNAL TO ACTIVATE SELECTED FIXTURE LED
109
DOES SHEET SENSOR INDICATE THAT ALL SHEETS AT THIS LOCATION HAVE BEEN REMOVED?
110
NO
YES
DO SENSORS INDICATE THAT REASSEMBLY AT THIS FIXTURE HAS OCCURRED?
111
NO
D
B

FIG. 7

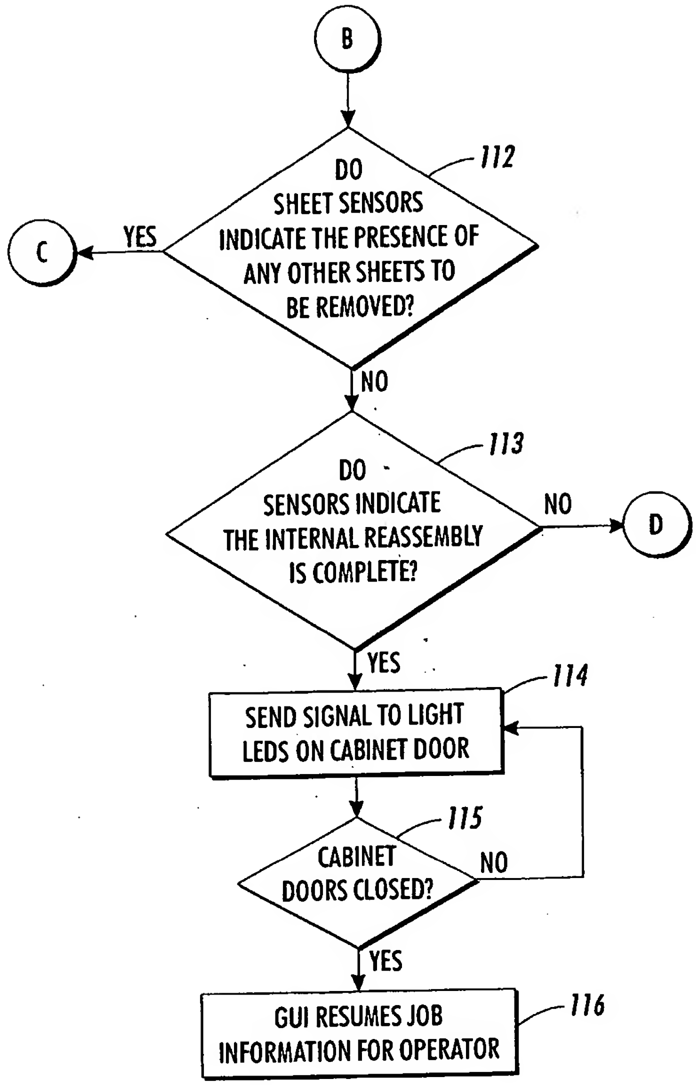
B
DO SHEET SENSORS INDICATE THE PRESENCE OF ANY OTHER SHEETS TO BE REMOVED?
112
YES
C
NO
DO SENSORS INDICATE THE INTERNAL REASSEMBLY IS COMPLETE?
113
NO
D
YES
SEND SIGNAL TO LIGHT LEDS ON CABINET DOOR
114
CABINET DOORS CLOSED?
115
NO
YES
GUI RESUMES JOB INFORMATION FOR OPERATOR
116

FIG. 8